Triploid Grass Carp for Aquatic Plant Control

UNITED STATES DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Fish and Wildlife Leaflet 8
Washington, D.C. • 1987

Fish and Wildlife Leaflets

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Library of Congress Cataloging-in-Publication Data

Clugston, James P.
Triploid grass carp for aquatic plant control.

(Fish and wildlife leaflet ; 8)
Supt. of Docs. no.: I 49.13/5:8
1. Aquatic weeds—Biological control.
2. Ctenopharyngodon idella. I. Shireman, J. V.
II. Title. III. Series.
SB614.C57 1987 632'.58 87-600027

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Triploid Grass Carp for Aquatic Plant Control

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Aquatic plants are often needed in ponds, lakes, and streams to ensure bottom stabilization and provide cover and food for aquatic and semi-aquatic animals. The plants become undesirable, however, when they become so abundant that they interfere with human needs and activities. In the United States, the reduction or elimination of unwanted aquatic plants has developed into a major and costly task.

Unwanted aquatic plants can be controlled by several methods or combinations of methods: water level manipulation, mechanical (physical) removal, application of chemicals, and introduction of plant-eating animals (biological control). The introduction of animals (primarily insects or herbivorous fish) that feed on aquatic vegetation has the advantage of providing relatively low-cost, long-term control, with few or no detrimental side effects when properly stocked. The grass carp (*Ctenopharyngodon idella*), a native of eastern Asia, appears to be well suited for use in vegetation control.

The grass carp was introduced into the United States from Malaysia and Taiwan in 1963 for aquatic plant control research. It now occurs, in the wild or under research conditions, in at least 35 States. Although no significant negative environmental impacts caused by this widespread distribution have yet been observed, uncertainties persist about the long-term ecological effects of this fish in open systems. Consequently, many States prohibit or restrict its use. However, special permits allowing the use of triploid grass carp (presumed to be sterile) for vegetation control are now issued by eight States: Florida, Georgia, Illinois, Kentucky, Nebraska, North Carolina, South Carolina, and Virginia. Other States are considering the controlled use of this fish. Stocking of all exotic or non-native fish must comply with current State and Federal regulations and must be approved by appropriate authorities.

Triploid Grass Carp

Characteristics

Triploid grass carp have 72 chromosomes, whereas normal diploid (fertile) grass carp have 48. Preliminary studies have indicated that the triploids are functionally sterile. They are produced by physically shocking fertilized eggs—by emersing them for a prescribed period in either warm or cold water, or using hydrostatic pressure—to stimulate the retention of a set of chromosomes normally expelled during cell division. Because the treatment does not produce 100% triploid fish, the number of chromosomes in each fish must be verified—

usually by electronically measuring the volume of the nucleus of a red blood cell after the cell membrane has been chemically removed. This procedure can be completed quickly with considerable accuracy. Such testing is required by most agencies before stocking is permitted.

The U.S. Fish and Wildlife Service, in a "Biological Opinion" on triploid grass carp issued on 2 December 1985, stated that there appears to be no reason to prohibit the stocking of triploid grass carp in either closed or open water systems. The opinion is based on recent research at the University of California at Davis, California, which indicated that female triploid grass carp are functionally sterile and that the sperm of male triploid grass carp is probably nonfunctional.

The opinion was written in response to a request from South Carolina. State fish and wildlife agencies that wish to use Federal aid funds for the introduction of exotic species into a natural ecosystem must receive a favorable "Biological Opinion" from the Service. The opinion for triploid grass carp was forwarded to all Service Regional Offices to be used if other States wish to use Wallop-Breaux or other Federal funds for studies on this fish. The opinion is essentially a legal document and has no intent of promoting triploid grass carp.

Vegetation Eaten

The grass carp is almost totally vegetarian after it reaches a length of about 4 in. (100 mm). The plants eaten (Table 1) and the rate of consumption vary with fish size, water temperature, water quality, and the kinds and combinations of aquatic plants available. Young fish up to about 2 in. (50 mm) long feed mostly on zooplankton. As they grow, the diet shifts to filamentous algae, duckweed, and soft pondweeds that contain little fiber. Although these pondweeds are preferred throughout life, large grass carp also eat emergent reeds, rushes, and sedges. In the absence of aquatic vegetation, grass carp feed on terrestrial plants overhanging the water or on supplemental cut vegetation.

Water Temperature

Each fish species has upper and lower lethal water temperatures and, within that range, optimum or specific temperatures that favor key life processes such as growth and reproduction. Because the range of temperatures at which grass carp can live and function is much wider than that of most other herbivorous fish, this species is potentially useful throughout the United States. Although grass carp eat irregularly at 3–6°C (37–43°F), feeding becomes steady at about 14°C (57°F) and peaks at 20–26°C (68–79°F). Feeding decreases when water temperature reaches about 33°C (91°F).

Table 1. *Some common aquatic vegetation eaten by grass carp in the United States.*

Algae
Filamentous algae
Cladophora spp.
Pithophora spp.
Muskgrass
Chara spp.
Stoneworts
Nitella spp.
Floating plants
Duckweed
Lemna spp.
Wolffia spp.
Water hyacinth
Eichhornia crassipes
Water fern
Azolla spp.
Emergent plants
Alligator weed
Alternanthera philoxeroides
Smartweed
Polygonum spp.
Arrowhead
Sagittaria spp.
Cattail
Typha spp.
Spikerush
Eleocharis spp.
Submersed plants
Coontail
Ceratophyllum spp.
Pondweeds
Potamogeton spp.
Naiads
Najas spp.
Watermilfoil
Myriophyllum spp.
Elodeas or waterweed
Elodea spp.
Hydrilla verticillata
Eelgrass or wildcelery
Vallisneria americana

Stocking Rates

Consumption rates of submersed vegetation are directly related to fish size, water temperature, and type of vegetation. The quantity of weeds eaten per unit of body weight is greater in small grass carp than in large ones. However, fish shorter than 8–10 in. (200–250 mm) should not be stocked when predaceous fish are present.

Recommended numbers of grass carp to stock for a specific level of vegetation control varies among States; rates now range from about 3 to 200 per acre, depending on the size of fish. In many areas further research is required to define effective stocking rates. The fish are generally stocked at the lower number in a recommended range; the rates of plant reduction are then observed for a time, and additional fish are stocked if needed to achieve the desired level of control. Adequate numbers should be stocked to remove the weeds within 2 years. Overstocking could reduce weeds too rapidly, resulting in degraded water quality and possible starvation of the grass carp. If fish can be moved to other ponds after weed control has been effected, high stocking rates might be biologically and economically feasible.

Stocking rates can be rather closely approximated by measuring the biomass (weight) of aquatic plants present, determining the fish growing season within the optimum temperature range (20–26°C), estimating food consumption rates, and choosing the period within which weed control is desired. Approximate food consumption rates (percentage of body weight eaten per day) differ for fish of different sizes: fish weighing less than 6 lbs (2.7 kg), 100%; 6–13 lbs (2.7–5.9 kg), 75%; and more than 13 lbs (5.9 kg), 25%.

An alternative to stocking large numbers of triploid grass carp is to treat the pond initially with herbicides to reduce the weed cover and then stock triploid grass carp to maintain control. Although the initial cost may be high, weeds can be controlled more quickly and with fewer fish.

Advantages of Triploid Grass Carp Over Other Herbivorous Fishes

A wide variety of fish eat vegetation, but only a few show potential for plant control. A good candidate species for biological control must eat the target vegetation in sufficient quantities to reduce standing crops and must be tolerant of a wide range of environmental conditions. The triploid grass carp meets these criteria. In addition, if it is indeed sterile, the establishment of wild populations in areas where it is unwanted is precluded.

Although various species of cichlids (*Tilapia*) and characoids (silver dollar fish) are used for weed control, they eat less vegetation per fish and are restricted to warm climates. They also are prolific and it is difficult to control population sizes.

Availability of Triploid Grass Carp

At least six hatcheries in the United States now commercially produce triploid grass carp. The number of sources may increase as production methods are perfected and the techniques become more widely known. Grass carp that are guaranteed to be triploid cost $4 to $5 per 8-in. (200-mm) fish. Costs should decrease as the availability of the fish increases.

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Key words: Grass carp (*Ctenopharyngodon idella*), triploid, herbivorous fish, aquatic plant control, exotic fish.

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☆ U.S. Government Printing Office: 1987—773-205/60016

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